DOCUMENT RESUME

ED 144 975 TM 006 494

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TITLE Acceptance Testing--Course Readiness Measurement.
PUB DATE 28 Apr 77
NOTE 15p.; Paper presented at the Annual Meeting of the Northeast Regional Conference of the American Institute for Decision Sciences (6th, Albany, New York, April 28, 1977)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Business Education; College Mathematics; Core Courses; Decision Making Skills; Higher Education; Individualized Instruction; Item Analysis; *Learning Readiness; Mastery Tests; Mathematical Applications; Program Improvement; *Screening Tests; *Statistics; Test Results; *Undergraduate Students
IDENTIFIERS University of Massachusetts Amherst

ABSTRACT

For several semesters, the teaching staff of the administrative statistics course at The University of Massachusetts have engaged in "acceptance testing"--the screening of incoming students for some very basic skills with an open book, unlimited time, repeatable test. Test results demonstrated that successful completion of prerequisite courses was no guarantee of readiness for courses which built upon the prerequisites. These results provided information that could be used to work with the mathematics and statistics department to correct deficiencies. A historical account of the testing program, a description of the implementation strategy, and an assessment of impact on the administrative statistics course (and on teachers of prior courses) are reported. (Author/MV)

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ACCEPTANCE TESTING - COURSE READINESS MEASUREMENT

(A paper presented to the sixth annual northeast regional conference of American Institute for Decision Sciences, Albany, New York, April 28, 1977)

by

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ACCEPTANCE TESTING - COURSE READINESS MEASUREMENT

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How often do students and teachers embark on a hopeless task--the learning/teaching of a skill for which some prerequisite capability does not exist? This article reports some findings, and a rationale for a practice, which stem from acting on the view that students with this sort of handicap are defective products of a supplier. For several semesters, the staff of Administrative Statistics at The University of Massachusetts have engaged in "acceptance testing"--the screening of incoming students for some very basic skills with an open book, unlimited time, repeatable test. A historical account, a description of political strategy and an assessment of impact on the Administrative Statistics course (and on teachers of prior courses) are given. Test results, some of them shocking, are also reported.

INTRODUCTION

All academic disciplines, in recent years, have been under pressure to improve the effectiveness of the delivery of their educational programs. Business schools would seem to be in an exceptionally favorable position to provide leadership in developing effective educational systems. Favorable job opportunities

for business school graduates continue to attract large numbers of students, increasing the need for the effective use of resources and decreasing the risks associated with innovation for schools where budgets are based on student numbers. Concurrently, the quality of entering students is improving. Given the management skills resident in a business school faculty, one would expect the educational experience to be organized, scheduled, and coordinated to derive maximum benefit from available resources. Finally, management scientists, operations researchers, or decision analysts of the faculties should be able to apply their analytical and scientific skills to identify and diagnose problems and to evaluate alternative solutions. While the record of innovation in business schools has not been exemplary, AIDS has consistently drawn attention to the problems associated with offering effective courses in the decision sciences. The paper contributes to this thrust by examining the role of acceptance (readiness) testing in improving the effectiveness of the introductory quantitative course in the business school.

All business majors at the University of Massachusetts are required to take Administrative Statistics. Prior to taking this course in the business school, students take two semesters of calculus and one semester of statistics from the Mathematics and Statistics Department. In a very real sense, the business school has contracted with this department as an outside supplier to deliver a service to its students. Administrative Statistics was conceived as a course that would build upon this mathematics background and develop students' skills in applying statistical methods

to the analysis of business problems. From its inception the course was a source of problems. Students complained about the difficulty of the course and the quality of instruction. Faculty complained about the quality of students. The status of management science in the business school declined. Few business school students elected quantitative courses beyond the basic required course. In fact, students began to delay taking the course until their junior and senior years reducing its value to other upper level courses, in reality, faculty who attempted to use quantitative methods in their courses were punished.

The course is a case oriented introduction to decision making techniques. The topics covered included:

1. Decision Trees
2. Value of Information
3. Preferences
4. Sampling
5. Simple and Multiple Regression

As problems with the course became apparent, several steps were taken by the faculty to improve the course. Extensive teaching notes were prepared to provide support for the teaching team and promote uniform coverage of course topics. Attention was focused on improving the delivery process. A system of common exams was was instituted to guarantee a uniform high quality of course output. Meetings were held with the math and stat department to coordinate coverage of materials. But problems continued and more extensive analysis was introduced.

Intensive Course Analysis

As part of the continuing effort to identify the source of course problems and to improve the effectiveness of the teaching experience the three phase analysis was expanded. First, the decision was made to experiment with alternative teaching systems. After one semester of preliminary experimentation, it was decided to conduct a full scale experiment with self paced instruction, "Keller Plan", or PSI. Half of the students were enrolled in traditional lecture discussion sections, while the remaining half were enrolled in the PSI sections. To measure relative effectiveness of the two approaches, common final exams were used. Finally, formal analysis of the readiness of incoming students was initiated.

Implementation of Readiness Tests

Despite the three course math. stat. prerequisite, the teaching faculty continued to be dissatisfied with the preparation of incoming students. To evaluate the validity of this concern, it was decided to introduce a readiness test. The first phase involved a series of discussions to specify the basic skills necessary for success in the course. This proved to be a surprising experience for all involved. Initially, faculty specified a rather wide range of skills as necessary to success in the course. However, as discussions proceeded, it was determined that the kinds of mathematical skills necessary were actually quite basic. The skills were divided into three broad categories. The first category, fundamentals, included basic algebra, the ability to read and interpret simple statements involving probabilities, and the ability to interpret probability mass functions and cdf's.

The second category was concerned with descriptive statistics; mean, mode, standard deviations, and frequency distributions. The final category included basic concepts of probability theory; joint, marginal, and posterior probability calculations and the binomial distribution.

The exam was used for the first time, in the fall of 1975, on a trial basis. It was intended to use the results of the exam to advise students about their readiness to continue in the course. The exam was open book, with no time limit and students were given two opportunities to demonstrate their knowledge. They were also given a sample examination; but, of necessity, only a few days before the first administration of the actual tests. In two attempts, barely 10% were able to demonstrate mastery level (90% correct in each section). Since the exams were open book with no time limit, and regarded as straight forward, the results were a shocking confirmation of some of the faculty's concerns.

The sample readiness examinations for the testing for spring, 1976 was distributed by statistics instructors late in the fall of 1975. Students were informed that admission in Administrative Statistics required successful performance on the readiness exam. While the results improved, they were still disappointing. Only 18% demonstrated mastery level (90% correct) in two attempts and 77% exceeded 67% correct in two attempts (the performance level necessary for admission).

Again prior to the third administration of the exam, sample readiness exams were distributed to faculty teaching statistics

and to prospective students. In the fall of 1976, 24% demonstrated mastery performance in two attempts, while 75% exceeded 75% correct in two attempts (the performance level necessary for admission).

The process of introducing such a readiness test is frought with several political pitfalls. The test was used to deny admission to a required course by students who had completed the specified prerequisites, an unpopular course no less! Several conditons helped to minimize potential problems. The innovations were supported by the teaching faculty in the course and by the Dean. (The chairman of the mathematics department was also very supportive.) Secondly, the exam questions were at such a basic level that other faculty were embarassed to oppose it. Moreover, communications with the students were extensive. There were numerous advance notices and sample exams. The exam conditions (no time limit, open book) could not be criticized as unfair. The requirement was applied without exception on a uniform basis to all sections. Finally, while mastery level was the ultimate goal, it was approached gradually.

Exam and Results

Some sample questions and results are given below:

1. Given:

$$A - L = P_2$$

$$P_2 = [P_1 + I - D + (R - E)]$$

What is the value of E?

Values of: $A = 110$ $I = 20$
$L = 20$ $D = 150$
$P_1 = 80$ $R = 500$

E =

This was correctly answered by 92.5% of all students.

2. Given:

$$\sigma_{\bar{x}_1 - \bar{x}_2} = \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

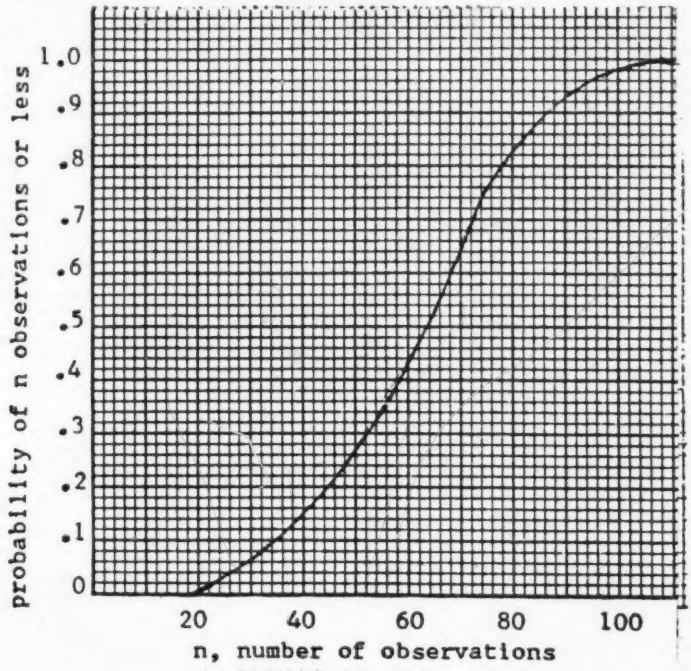
$\sigma_1^2 = 8100$ $n_1 = 100$

$\sigma_2^2 = 11{,}520$ $n_2 = 80$

$\sigma_{\bar{x}_1 - \bar{x}_2}$ =

This was correctly answered by 85.7% of the students.

3. In graph I what is the probability of having 78 or fewer observations?



This was correctly answered by 80.3% of the students.

7. Sharon has 3 chances in 7 of passing the bar examination. What is the probability that she will not pass?

p =

This was answered correctly by 85.7% of the students.

8. On 5 days of 11 it rains in Prix Soke, LA. What is the probability that it will rain on a given day?

p =

This was answered correctly by 85.7% of the students.

Section B - Measures of Central Tendency and Dispersion

Problems 9-16

Given the following data describe the number of cars sold per day for each of the 5 preceding days by Paydge's Chevrolet.

2 4 0 1 1

9. What is the expected number of cars sold per day?

This was answered correctly by 98% of the students.

10. What is the standard deviation of the number of cars sold?

This was answered correctly by 46.3% of the students.

Section C - Probability and Expected Value

Problems 17 - 24

In the following, these notations are the same.

a) p (S given C) or p (S|C)

b) p (f and B) or p (f $\cap$ B) or p(f,B)

Given: States of Nature Good = G
Bad = B

which are all of the possible states of nature

Outcomes of test - Red = R
Yellow = Y
Violet = V

which are all of the possible test outcomes

p(R|G) = .4	p(Y|G) = .1
p(G) = .6	p(Y|B) = .1
p(V|B) = .75	p(R|B) = .15

17. What is p(V)?

This was answered correctly by 72.8% of the students.

19. What is p(Y,B)?

This was answered correctly by 83% of the students.

20. What is P(V|G)?

This was answered correctly by 81% of the students.

22. What is the value of the conditional probability of the state of nature good, G, if the test outcome is red, R?

This was answered correctly by 46.9% of the students.

23. What is the value of the joint probability of both a test outcome of Yellow and a state of nature, Good?

This was answered correctly by 74.8% of the students.

24. The marginal probabilities are:
This was answered correctly by 42.2% of the students.

While the poor overall results had been surprising, the specific details of the item analysis were shocking. fewer than 50% of the students could correctly calculate a standard deviation for 5 observations in an open book exam after having passed a one semester course in statistics! About 15% of the students had difficulty substituting numbers in a formula and solving for an unknown value. The results clearly demonstrated that successful completion of prerequisite courses is no guarantee of readiness for courses which build upon the prerequisites. Many students had obviously failed to master some very basic concepts and skills.

While the results were disappointing, they were objective information identifying a major source of course difficulties. It was information that could be used to work with the mathematics and statistics department to correct deficiencies.

This simple device has yielded many benefits. The tests themselves are explicit statements to the mathematics and statistics departments of some minimum skill levels that must be achieved by students. In response to the tests, in the fall of 1976, a new book was chosen by the math and statistics department, and a common final exam was instituted for the first time.

Instructors of Administrative Statistics consistently remarked that, in the spring of 1976, teaching was more pleasant and classroom participation was much greater than in the fall of

1975. Improved performance was borne out by final exam results in the spring semester. The unprepared students were screened out by the readiness test. Twenty-five graduating seniors who did not meet the requirements were admitted. All sections used common exam questions similar in format and difficulty to those used in the fall of 1975. The course failure rate dropped to seven students out of 370. Six of the seven were among students who failed to meet the readiness test requirements. This group also accounted for a disproportionate share of D's and CD's. It undoubtedly saved some students the wasted effort of taking a course for which they were not prepared. Not only did the overall class average rise, but the Assistant Dean for Undergraduate Programs commented that students complaints about the course dropped to an unprecendented low.

After an initial chorus of student complaints about the impropriety of a readiness test, complaints have diminished dramatically. Support from the Dean helped to quiet some of the initial objections. Moreover, its success has led three other instructors to introduce readiness testing to their courses.

Conclusion:

One would never try to assemble an airplane the way we try to assemble a business education. It would never get off of the ground. Certainly there are characteristics of a production line that we would wish to avoid in the educational process. However, there are many basic notions that we teach in our business courses which usefully apply to our educational programs. To insure high product quality and efficient use of resources, quality checks

are regularly made at various points in the production process. Parts provided by a supplier are tested prior to acceptance. (Accountants rightly argue that audits, by their routine nature, eliminate much sub-standard reporting.) Precise performance specifications are given to suppliers. In the university, we have sought to achieve similar ends by specifying prerequisite courses. It is our experience that this is an inadequate procedure. We have found using a readiness test is far more effective.

The benefits to be derived from a readiness test are several:

1. It explicitly defines expectations and responsibilities of all parties involved; students, faculty in preparatory course, and faculty in the course involved.

2. Resources are applied more effectively as faculty can rely on a base level of skills and students will not waste time in courses for which they are not prepared.

3. It can help identify and locate problems in a teaching program, quickly.

4. It can serve as a device for explicitly communicating expected progress toward the achievement of desired professional skills.

5. Students can more clearly see their courses as related building blocks, not as individual hurdles to be lept and left behind.

The introduction of readiness testing in a curriculum is a small, rather simple step. The potential payoffs appear large. It is, however, but one aspect of the teaching process. Certainly many man years of effort have been devoted to the evalu-

ation of alternative teaching technologies. Through the combination of improved teaching methods and management of the educational program we believe there is great potential for a major breakthrough in developing more effective educational systems.

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